ASED http://e-ASED.org
Animal Systematics, Evolution and Diversity

Anim. Syst. Evol. Divers. Vol. 35, No. 3: 123-135, July 2019
https://doi.org/10.5635/ASED.2019.35.3.019

Two Newly Recorded Species of the Genus *Elaphognathia* (Crustacea, Isopoda, Gnathiidae) from Korean Waters

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ABSTRACT

Elaphognathia monodi (Gurjanova, 1936) and *Elaphognathia kikuchii* Nunomura, 1992 are newly reported based on the materials collected from Wando Island and Jeju Island in Korea, respectively. *Elaphognathia monodi* is distinguished by the following characteristics: the lateral margin of the cephalon is narrowing posteriorly; the frontal border is slightly concave and has a small mediofrontal process, a pair of superior frontolateral processes, and a pair of inferior frontolateral processes. *Elaphognathia kikuchii* can be distinguished by the following characteristic features: the lateral margin of the cephalon is narrowing anteriorly; the frontal border has a small mediofrontal process and twelve pairs of simple setae along with concavity.

Keywords: *Elaphognathia*, Gnathiidae, isopods, morphology, taxonomy, Korea

INTRODUCTION

The family Gnathiidae Leach, 1814, including over 200 species in 12 genera, have a strong sexual dimorphism: The adult male of the gnathiid isopods has conspicuous mandibles, while the adult female lacks those and has a swollen body (Boyko et al., 2008; Ota, 2013). Furthermore, the members of gnathiid isopods show parniza stage which has needle-like mouthparts being adapted for sucking fish blood. They also show a cryptic behavior because the adults are non-feeder, whereas the pariza stage feed fish blood (Svavarsson and Bruce, 2012). Among the gnathiid isopods, the genus *Elaphognathia* Monod, 1926 including 23 species can be easily distinguished from other gnathiid genera by having deeply excavated frontal margin of the cephalon, long and cylindrical mandibles, often lacking mandibular blade, and pereonite 1 fused to the cephalon (Cohen and Poore, 1994; Ota et al., 2010; Svavarsson and Bruce, 2012; Ota, 2013).

Nine *Elaphognathia* species have been known in East Asia: *Elaphognathia bacescoi* (Kussakin, 1969); *Elaphognathia cornigera* (Nunomura, 1992); *Elaphognathia discolor* (Nunomura, 1988); *Elaphognathia kikuchii* (Nunomura, 1992); *Elaphognathia lucanoides* Monod, 1926; *Elaphognathia monodi* (Gurjanova, 1936); *Elaphognathia nunomurai* Ota, Tanaka, Hirose and Hirose, 2010; *Elaphognathia strombosa* Nunomura, 2012; *Elaphognathia sugashimaensis* (Nunomura, 1981) (see Monod, 1926; Gurjanova, 1936; Kussakin, 1969; Nunomura, 1981, 1988, 1992, 2012a, 2012b; Müller, 1989; Ota et al., 2010; Song and Min, 2016). In Korean waters, only *E. sugashimaensis* has been reported by Song and Min (2016). In this study, we newly report two *Elaphognathia* species, *E. monodi* and *E. kikuchii*, with detailed illustrations and descriptions based on the Korean materials.

MATERIALS AND METHODS

Single specimen of *E. monodi* was collected from the intertidal zone of Soan Island in Korean waters (34°10′48″N, 126°38′05″E) using a sieve with mesh size of 1 mm. Specimens of *E. kikuchii* were collected from the subtidal zones of Jeju Island by using Smith-Mclntyre grab. The collected samples were immediately fixed in 95% ethanol and transferred to the laboratory. A stereomicroscope (Nikon SMZ 1500, Japan)

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eISSN 2234-8190

and a bright field microscope (Olympus, BX 50, Japan) were used to observe the specimens. Measurements and drawing of the specimens were carried out with an aid of a drawing tube and camera lucida. The examined materials in the present study were deposited at the National Institute of Biological Resource (NIBR) and Chosun University in Korea.

SYSTEMATIC ACCOUNTS

Order Isopoda Latreille, 1817
Suborder Cymothoida Wägele, 1989
Family Gnathiidae Leach, 1814
Genus *Elaphognathia* Monod, 1926

[1]*_Elaphognathia monodi_ (Gurjanova, 1936) (Figs. 1–4)

Gnathia (*Elaphognathia*) *monodi* Gurjanova, 1936: 256–258, Abb. 5.
Elaphognathia monodi Cohen and Poore, 1994: 288.

Material examined. Korea: 1♂, Jeollanam-do: Wando-gun, Soan-myeon, Iwol-ri, 34°10′48″N, 126°38′05″E, 27 May 2017, cat on NIBRIV0000835376.

Description of male. Body 3.4 times longer than greatest width; length 4.3 mm. Cephalon oblong, 0.7 times as long as wide, lateral margins narrowing posteriorly. Frontal border slightly concave, with 1 small mediofrontal process, 1 pair of superior frontolateral processes, 1 pair of inferior frontolateral processes; frontolateral process with several simple setae. Dorsal sulcus located on medial region, deep and wide, V-shaped. Supraocular lobes with smooth apex, not prominent. Eyes large, round, dark, positioned on lateral margin; ommatidia arranged in rows. Pereonite 1 fused to cephalon; suture line visible dorsally. Pereonite 2 oblong, wider than length; pereonite 3 similar to pereonite 2 in shape, slightly wider than pereonite 2; pereonite 4 narrower than pereonites 2 and 3, with anterior constriction; pereonite 5 expended posterolaterally; pereonite 6 longest, with concave posterior margin; pereonite 7 minute, overlapping pleonite 1. Pleonites similar to each other in length, subparallel laterally, slightly concave on posterior margin. Pleotelson triangular, with 2 simple setae distally; apex subacute, with 2 simple setae on distal end (Fig. 1A–C).

Antennule composed of 3 peduncles and 5 flagellar articles; peduncle article 1 oblong, with 2 simple setae and 1 penicillate seta distally; article 2 rectangular, slightly shorter than article 1, with 1 simple seta and 4 penicillate setae on distal margin; article 3 slender, 1.9 times as long as article 2, with 4 simple setae on lateral margin and 9 simple setae on distal end; flagellum article 1 short, oblong; article 2 4.4 times longer than article 1; article 3 shorter than article 2, with 1 aesthetasc distally; article 4 0.8 as long as article 3, with 1 aesthetasc; article 5 small, with 1 penicillate seta, 4 simple setae, and 1 aesthetasc distally (Fig. 1D).

Antenna consisted of 4 peduncles and 6 flagellar articles; peduncle article 1 1.3 times longer than article 2; article 2 with 1 simple seta on distal end; article 3 oblong, 1.2 times as long as article 2; article 4 slender, 2.9 times longer than article 3, with 2 simple setae laterally, 1 penicillate seta and 9 simple setae distally; article 5 subequal to article 4 in length, with 4 simple setae laterally, 7 simple setae and 3 penicillate setae distally; flagellar articles similar in length, sequentially narrower in width, with 1–5 simple setae on distal end (Fig. 1E).

Mandible 1.2 times longer than cephalon, with 1 madibular seta and smooth blade; apex curved internally; internal lobe and erisma present; dorsal lobe and teeth absent; basal neck distinct (Figs. 1A, B, 2A).

Maxilliped, endite reaching to proximal end of palp article 1; palp articles consisted of 4 articles, with plumose setae on outer margin; article 1 rectangular; article 2 1.5 times longer than article 1, longest; article 3 1.4 times as long as article 4; article 4 similar to article 3 in length; apex round, with 4 simple setae distally (Fig. 2B).

Pylopod consisted of 3 articles; article 1 oval to triangular, 0.8 times longer than total length of pylopod, with numerous plumose setae on outer margin, 4 simple setae on distal end, and numerous fine setae on inner margin, and without areolae; article 2 ovoid, 0.2 times as long as article 1, with numerous fine setae laterally and 2 simple setae distally; article 3 minute, with 1 simple seta and several fine setae distally (Fig. 2C, D).

Pereopods 2–6 resemble to each other in shape, pereopod 2 without tubercles on merus and carpus; basis longest, with 0–2 penicillate setae on superior margin, several simple setae along with superior and inferior margins; ischium shorter than basis, with several simple setae along with superior and inferior margins; merus almost half of ischium in length, with 1 tubercle and 3 simple setae on inferior margin, several simple setae on superodistal angle; carpus shorter than merus, with 1 tubercle, 1 serrate seta, several simple setae on inferior margin, 0–2 simple setae on superodistal angle; propodus slender, subequal to ischium, with 2 serrate setae and several short simple setae on inferior margin, simple setae on superior margin, without penicillate setae except on pereopod 2 (1 penicillate seta present at propodus of pereopod 2); dactylus oblong, shortest, with 2–4 simple setae and 1 claw on distal end (Fig. 3A–E).

Korean name: [1]*네돌기오목머리큰턱벌레 (신칭)

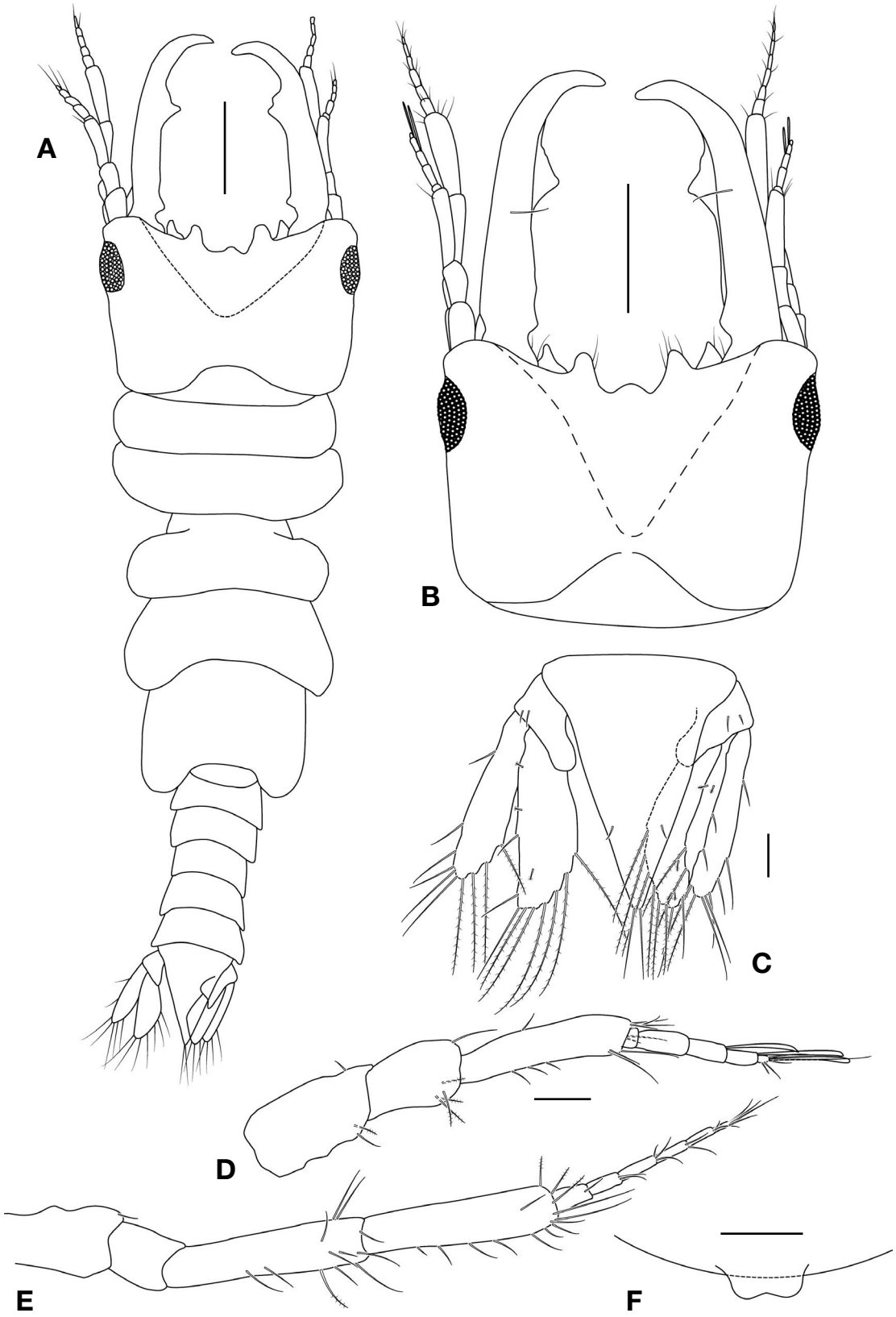

Fig. 1. *Elaphognathia monodi*, male. A, Habitus, dorsal view; B, Cephalon; C, Pleotelson and uropod; D, Antennule; E, Antenna; F, Penes. Scale bars: A, B = 0.5 mm, C–E = 0.2 mm, F = 0.1 mm.

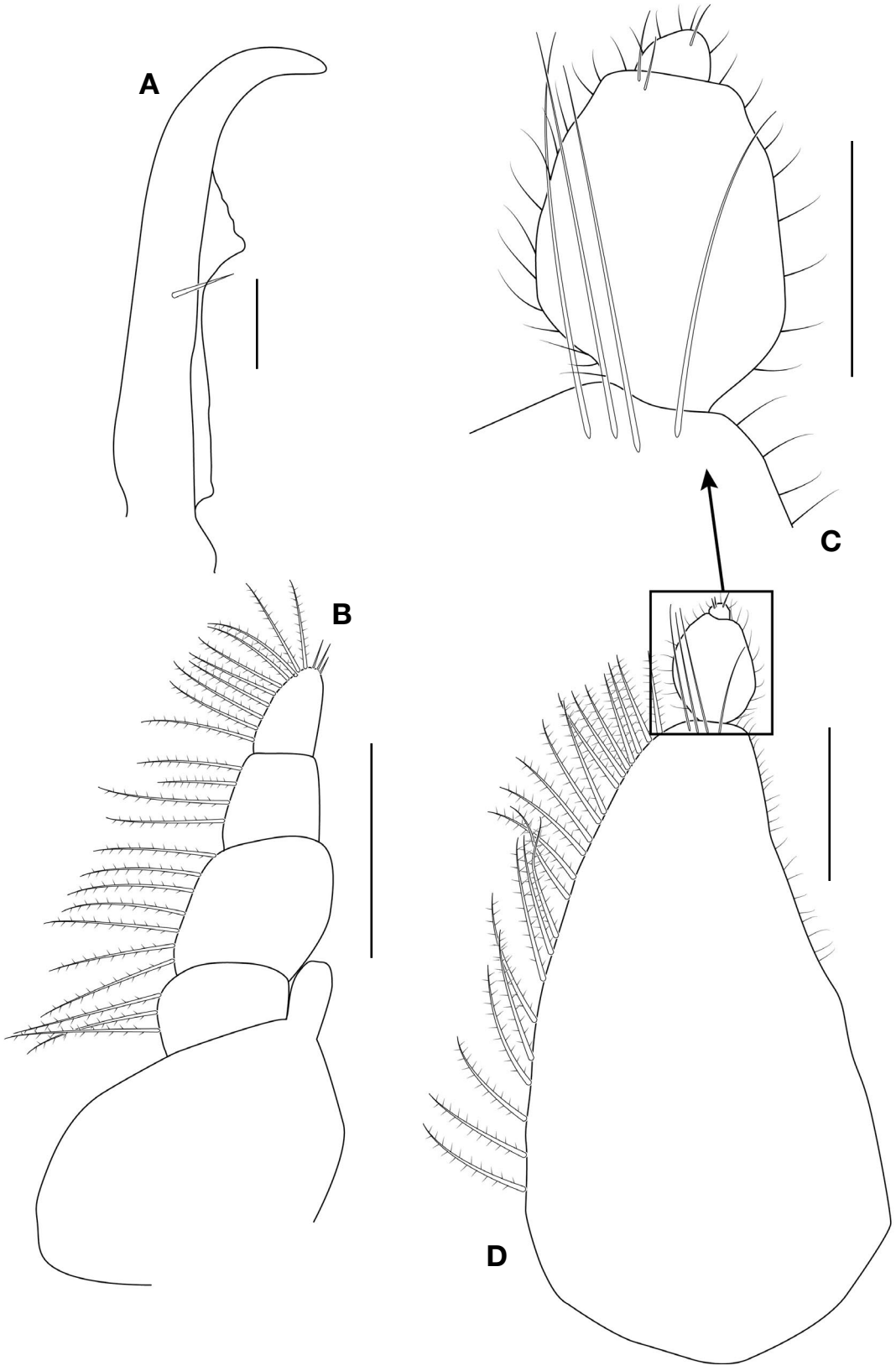

Fig. 2. *Elaphognathia monodi*, male. A, Mandible, dorsal view; B, Maxilliped; C, Distal end of pylopod; D, Pylopod. Scale bars: A, B, D = 0.2 mm, C = 0.1 mm.

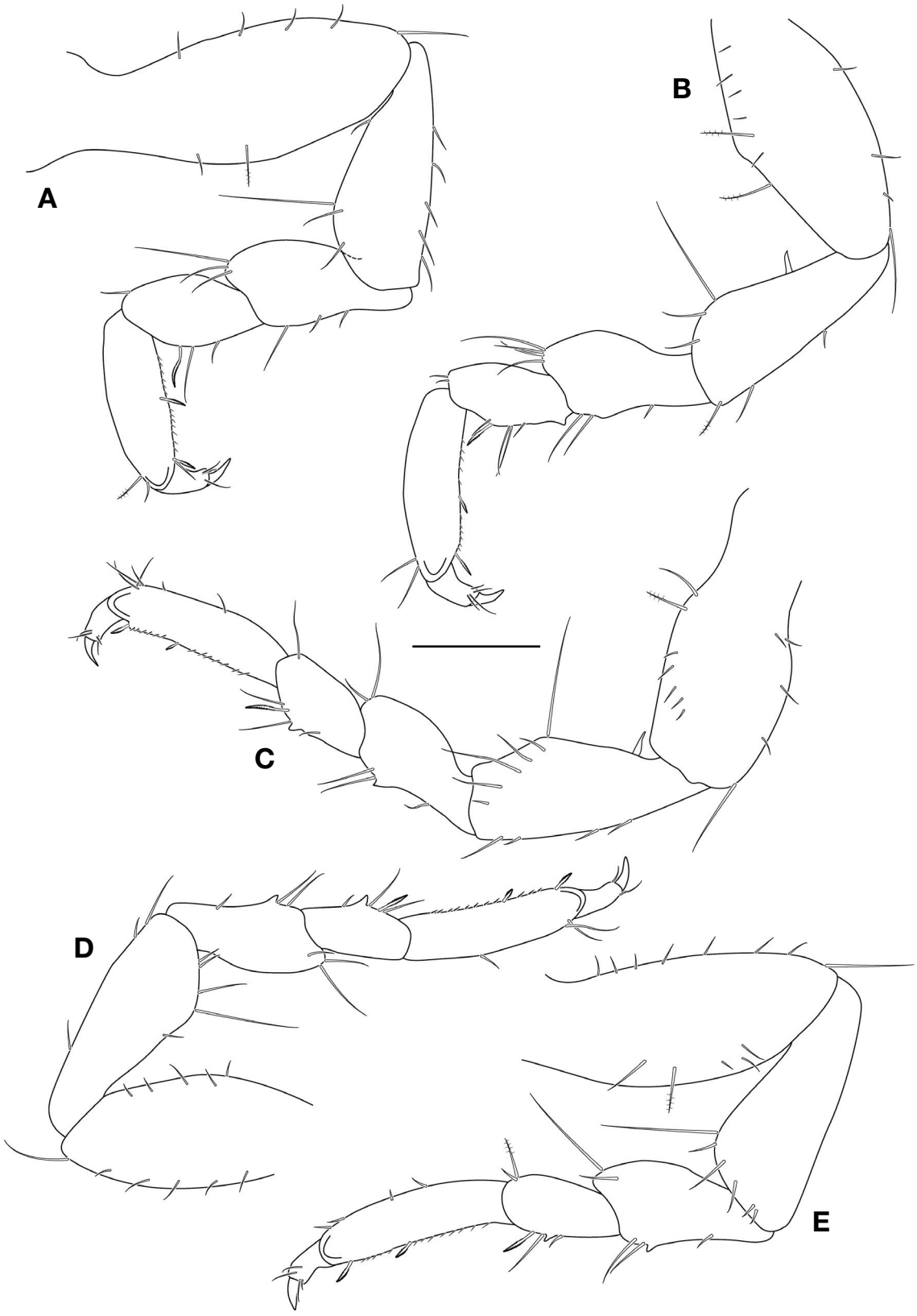

Fig. 3. *Elaphognathia monodi*, male. A, Pereopod 2; B, Pereopod 3; C, Pereopod 4; D, Pereopod 5; E, Pereopod 6. Scale bar: A–E= 0.2 mm.

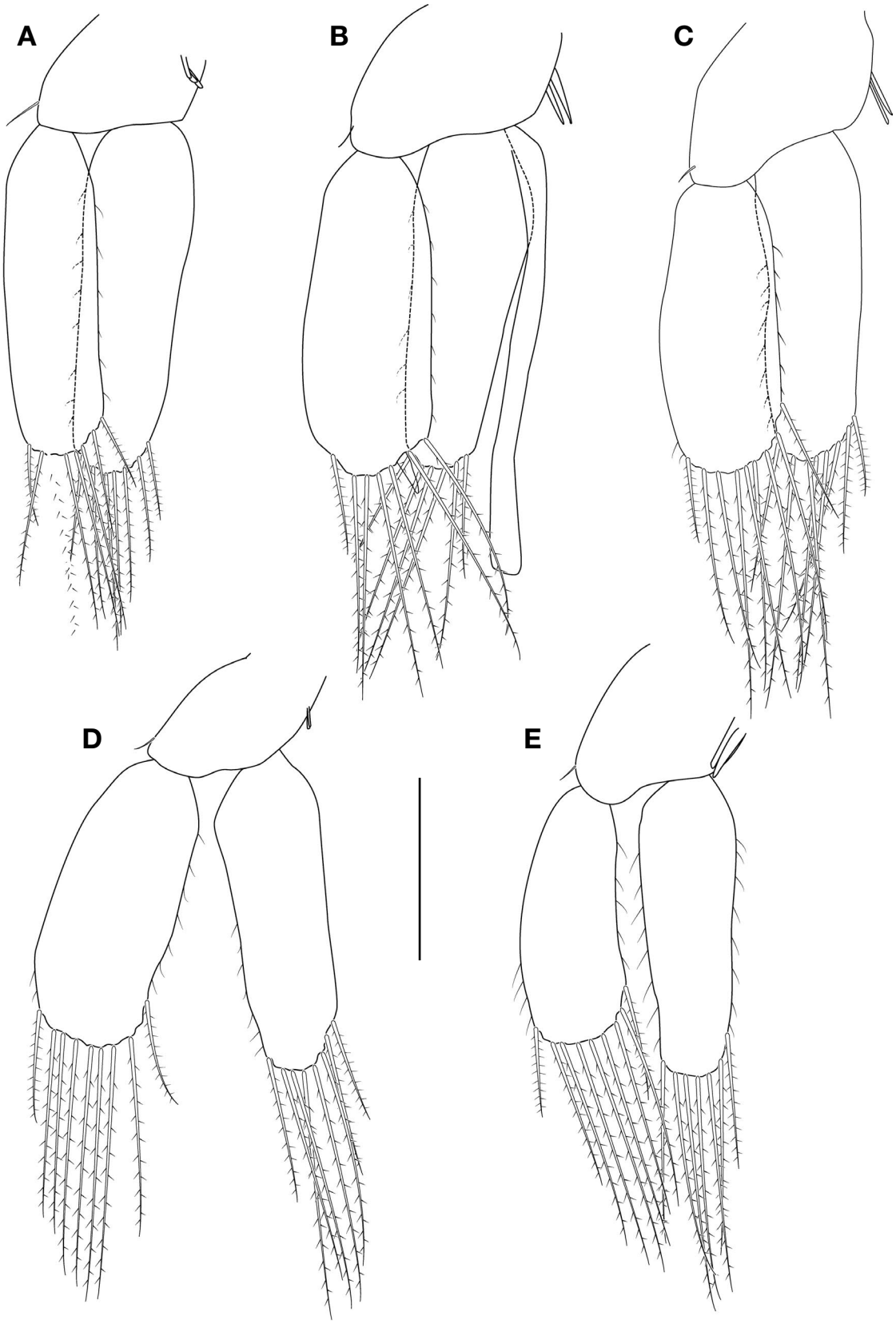

Fig. 4. *Elaphognathia monodi*, male. A, Pleopod 1; B, Pleopod 2; C, Pleopod 3; D, Pleopod 4; E, Pleopod 5. Scale bar: A–E=0.5 mm.

Pleopods 1–5 similar to each other in shape; protopod ovoid to oblong, with 2–3 coupling hooks on inner margin, 1 simple seta on outer margin; rami subequal in length, elongated oblong or ovoid, with rounded apex, with fine setae laterally, plumose setae distally; appendix masculine longer than rami, with rounded apex (Fig. 4A–E).

Uropod, protopod triangular, 0.5 times longer than endopod, with 2 simple setae dorsally; rami fringed on inner margin, with rounded apex; endopod slightly longer than exopod, with plumose setae on inner margin, simple setae on outer margin, 3 or 5 penicillate setae on dorsal margin; exopod with plumose setae on inner margin, simple setae on outer margin (Fig. 1C).

Penes basally fused, of papillae shape (Fig. 1F).

Habitat. Mud flat of intertidal zone.

Distribution. Japan, Korea (present study).

Remarks. The Korean material of single specimen and the original description of *E. monodi* by Gurjanova (1936) have a minor difference in terms of the mandible endite (reaching to the proximal end of palp article 1 in the Korean material vs. lacking in the original illustration). However, they are well corresponded with each other by having the mandible with internally curved apex and a mediofrontal process with two pairs of frontolateral processes on the cephalon, which are regarded as the remarkable characteristics of *E. monodi*.

There are nine species having both frontolateral and mediofrontal processes in the genus *Elaphognathia*: *Elaphognathia amboinensis* (Cals, 1978); *Elaphognathia australis* Svavarsson and Bruce, 2012; *Elaphognathia bacescoi* (Kussakin, 1969); *Elaphognathia ferox* (Haswell, 1884); *Elaphognathia forceps* (Holdich and Harrison, 1980); *Elaphognathia froygattella* Cohen and Poore, 1994; *Elaphognathia insolita* (Stebbing, 1905); *Elaphognathia monodi* (Gurjanova, 1936); *Elaphognathia wolffi* (Müller, 1989). Among them, *E. monodi* differs from other species by the number of the frontolateral processes (one pair of superior and one pair of inferior frontolateral processes in the former vs. only one pair of frontolateral processes in the latter) (Haswell, 1885; Stebbing, 1905; Gurjanova, 1936; Kussakin, 1969; Cals, 1978; Holdich and Harrison, 1980; Müller, 1989; Cohen and Poore, 1994; Svavarsson and Bruce, 2012).

The Korean material of *E. monodi* can be distinguished from *E. sugashimaensis* by having mediofrontal and inferior frontolateral processes (vs. only having superior frontolateral processes in the latter) (Song and Min, 2016).

[1]**Elaphognathia kikuchii* (Nunomura, 1992) (Figs. 5–8)

Gnathia kikuchii Nunomura, 1992: 61–63, fig. 2.
Caecognathia kikuchii Cohen and Poore, 1994: 288.
Elaphognathia kikuchii Ota, 2013: 35–42, figs. 2–4.
Gnathia amakusaensis Nunomura, 1992: 63–65, fig. 3.
Gnathia saikaiensis Nunomura, 1992: 67–69, fig. 5.

Material examined. Korea: 9♂♂, Jeju-do, Seoqwipo-si, Daejeong-eup, 33°12′48″N, 126°19′23″E, 31 Jan 2018, depth 65 m, cat no. NIBRIV0000834648; 1♂, 33°11′10″N, 126°17′53″E, 24 Apr 2018, depth 30 m; 1♂, 33°13′53″N, 126°36′15″E, Songsang-dong, 26 Apr 2018, depth 25 m.

Description of male. Body 3.4 times longer than greatest width; length 4.2 mm; dorsal surface smooth. Cephalon almost square, 0.9 times as long as wide; dorsal surface with short setae; lateral margins narrowing anteriorly; frontal border mesially concave, with small mediofrontal process, with 12 pairs of simple setae along with concavity; dorsal sulcus positioned at medial region, shallow, wide, U-shaped; supraocular lobe not prominent with smooth apex. Eyes large, round, located at lateral margin, with dark pigment; ommatidia arranged in rows. Pereonites subparallel laterally; pereonite 1 fused to cephalon dorsally; pereonites 2 and 3 resemble to each other in shape; pereonite 4 with anterior constriction; pereonite 5 widest, convex laterally; pereonite 6 similar to pereonite 5 in length, concave on posterior margin, pereonite 7 minute, overlapping pleonite 1. Pleonites subequal in length, narrowing posteriorly, pleonite 2 slightly wider than other. Pleotelson triangular, convex laterally, with 2 pairs of short simple setae on proximal and distal region; apex rounded, with 2 simple setae distally (Fig. 5A, B, E).

Antennule consisted of 3 peduncles and 4 flagellar articles; peduncular article 1 oblong to ovoid, with 2 penicillate setae laterally, article 2 subequal in length, oblong, with 3 penicillate and 2 simple setae anterolaterally, article 3 1.6 times as long as article 2, with 3 simple setae laterally, 1 simple seta distally; flagellar article 1 shortest, 0.3 times as long as article 2, with 1 short simple and 1 penicillate seta mesially, articles 2–4 resemble in length, article 2 with short simple seta mesially, article 3 with simple seta distally, article 4 with 1 simple seta and 1 aesthetasc distally (Fig. 5C).

Antenna composed of 4 peduncles and 7 flagellar articles; peduncle articles 1 and 2 similar to each other in length, article 3 1.8 times longer than article 2, with 2 penicillate and 3 simple setae subdistally, article 4 subequal to article 3 in length, with 5 penicillate and 7 simple setae distally; flagellar articles similar in length, sequentially narrowing, article 1 with 1 penicillate and 1 simple seta on distal end, articles 2–7 with 1–4 simple setae distally (Fig. 5D).

Mandible 0.4 times longer than cephalon, pliers shaped, with 1 mandibular seta; apex curved internally; armed carina distinct, positiond on middorsal; incisor elevated, with den-

Korean name: [1]*수염오목머리큰턱벌레 (신칭)

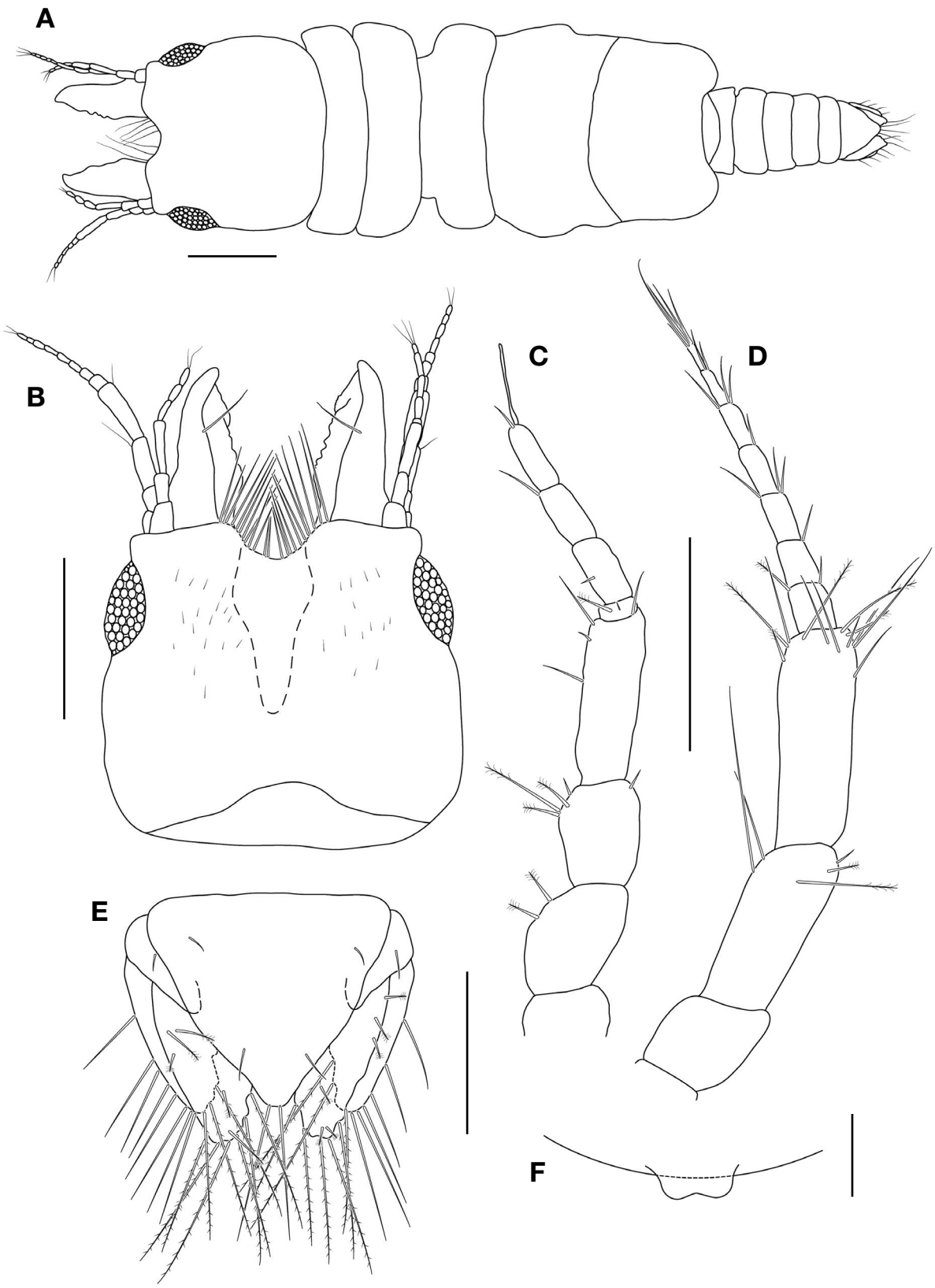

Fig. 5. *Elaphognathia kikuchii*, male. A, Habitus, dorsal view; B, Cephalon; C, Antennule; D, Antenna; E, Pleotelson and uropod; F, Penes. Scale bars: A, B = 0.5 mm, C–E = 0.2 mm, F = 0.1 mm.

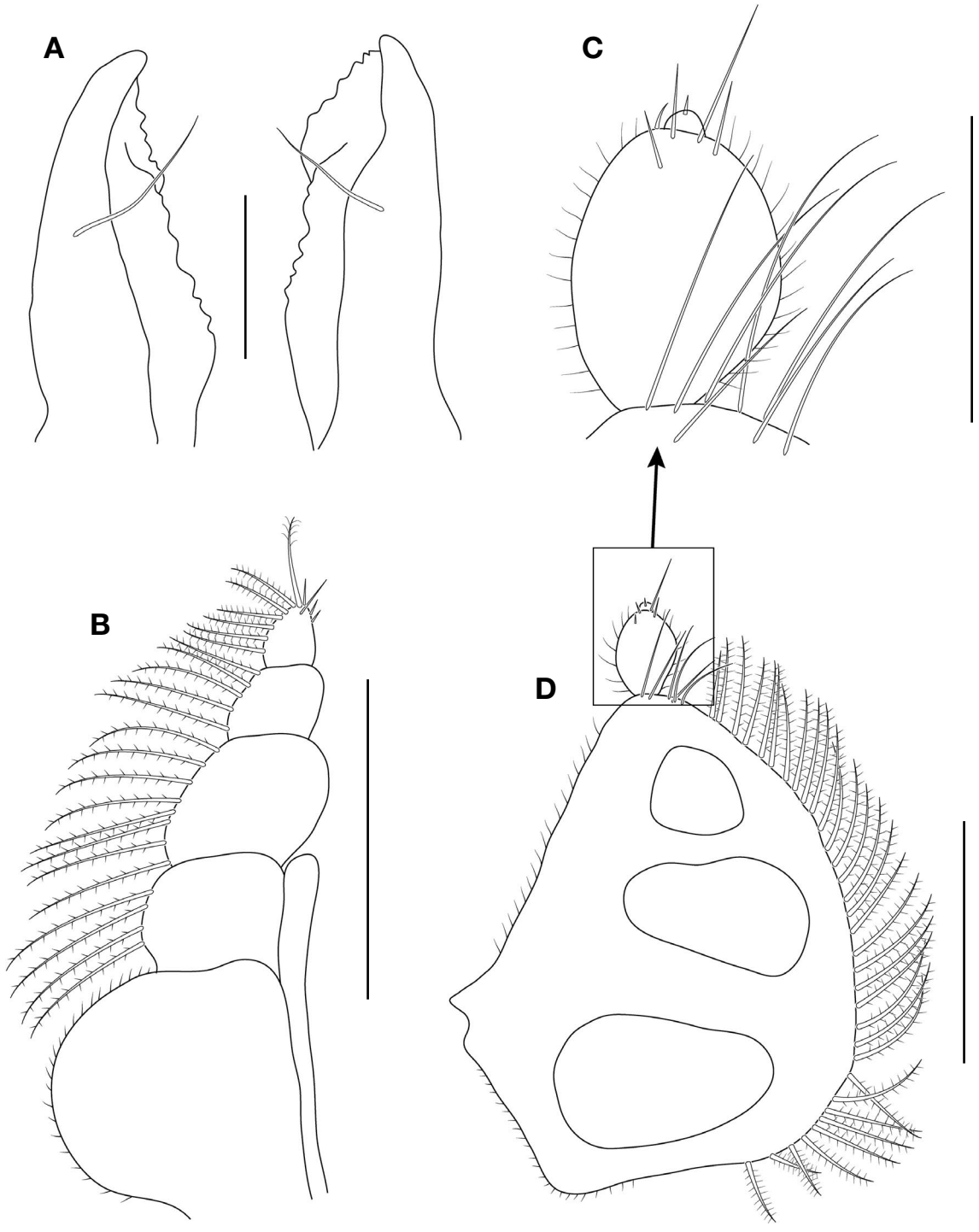

Fig. 6. *Elaphognathia kikuchii*, male. A, Mandible, dorsolateral view; B, Maxilliped; C, Distal end of pylopod; D, Pylopod. Scale bars: A, C = 0.2 mm, B, D = 0.5 mm.

tate blade; basal neck indistinct (Figs. 5A, B, 6A).

Maxilliped, endite extended to distal end of palp article 1; palp composed of 4 articles, with plumose setae on external margins, similar in length, continuously narrowing, article 2 widest, article 4 with 4 simple setae distally (Fig. 6B).

Pylopod composed of 3 articles; article 1 0.8 times as long as articles 1–3, triangular to semicircular, with numerous plumose setae on outer margin, 8 simple setae on distal end,

Fig. 7. *Elaphognathia kikuchii*, male. A, Pereopod 2; B, Pereopod 3; C, Pereopod 4; D, Pereopod 5; E, Pereopod 6. Scale bar: A–E= 0.2 mm.

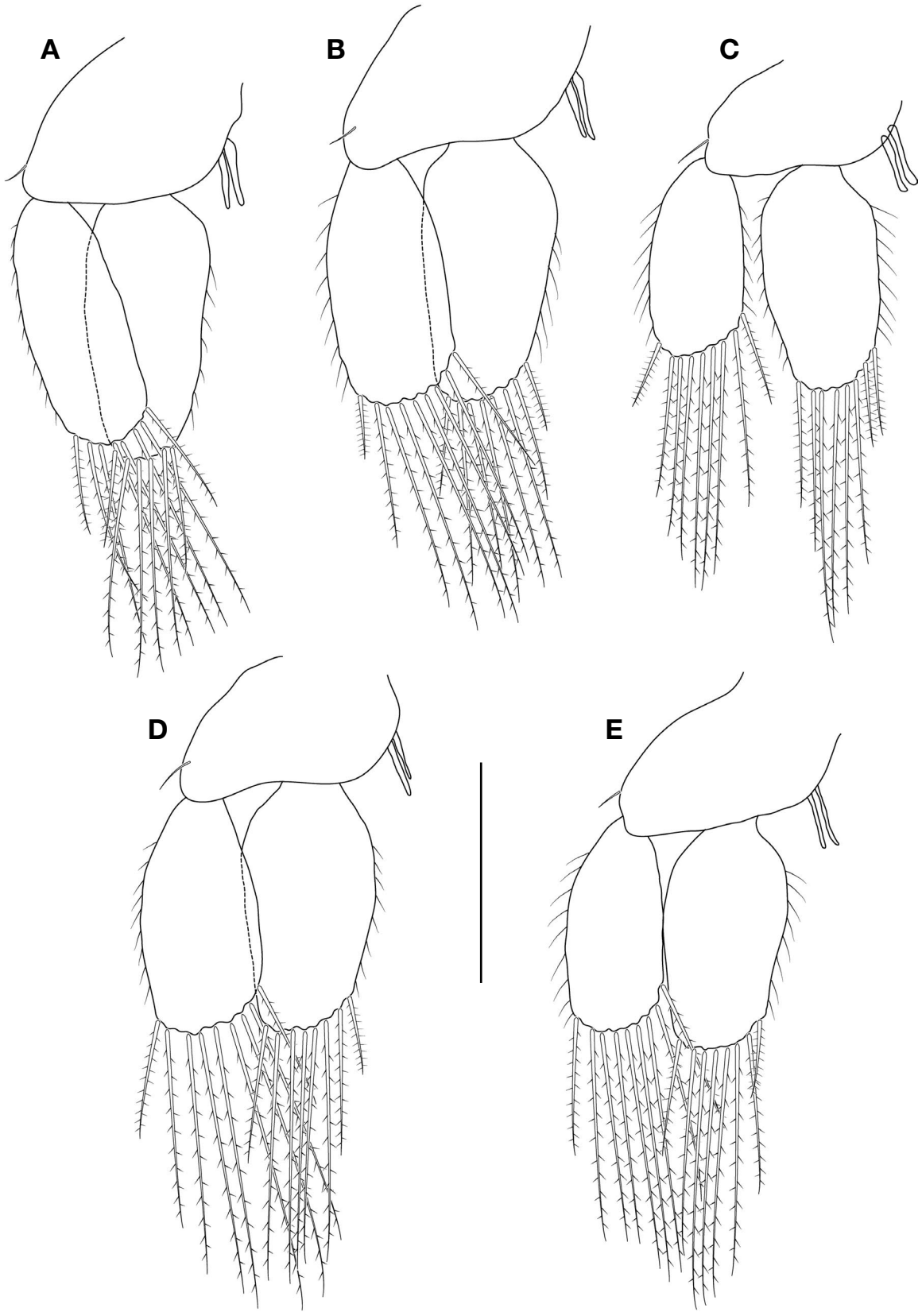

Fig. 8. *Elaphognathia kikuchii*, male. A, Pleopod 1; B, Pleopod 2; C, Pleopod 3; D, Pleopod 4; E, Pleopod 5. Scale bar: A–E = 0.5 mm.

and fine setae on inner margin, with 3 areolae; article 2 ovoid, about 0.2 times longer than article 1, with fine and 5 simple setae on lateral and distal region, respectively; article 3 minute, with 1 simple seta distally (Fig. 6C, D).

Pereopods 2–6 similar to each other in shape; basis longest, with 2–3 penicillate setae and several simple setae on superior margin, several simple setae along with inferior margin; ischium with simple setae on superodistal angle, several simple setae and tubercles along with inferior margin; merus about half of ischium in length, with 2–3 simple setae on superodistal angle, several simple setae and tubercles along with inferior margin; carpus subequal to merus in length, with 0–1 penicillate seta on superodistal angle, 1–2 simple setae on superior margin, 2 tubercles and several simple setae along with inferior margin, 1 serrate seta superodistally in pereopod 6; propodus slender, with 1 penicillate seta on superodistal angle, several simple setae on superior margin, 2 robust simple setae and short simple setae on inferior margin, dactylus rectangular, with several simple setae and 1 claw distally (Fig. 7A–E).

Pleopods 1–5 resemble to each other in shape; protopod trapeziform, with 1 simple seta on outer distal end and 2 coupling hooks on inner margin; rami elongated ovoid shape, endopod longer than exopod, with fine setae laterally, plumose setae distally; appendix masculine not observed on pleopod 2 (Fig. 8A–E).

Uropod, protopod triangular, with 1 simple seta mesially; rami fringed on inner margin; endopod longer than exopod, with simple setae on outer margin, plumose setae on inner margin, 3 penicillate setae on mesial margin, exopod with plumose setae distally, 1 penicillate seta mesially (Fig. 5E).

Penes papillae shape basally fused (Fig. 5F).

Distribution. Japan, Korea (present study).

Remarks. According to Ota (2013), five species, *Caecognathia amakusaensis* (Nunonura, 1992), *Caecognathia saikaiensis* (Nunomura, 1992), *Gnathia azumai* (Nunomura, 2012), *Gnathia quadricephala* (Nunomura, 2012), and *Gnathia recticornata* (Nunomura, 2012), are the junior synonyms of *E. kikuchii* (Nunomura, 1992). They share several characteristic features of *E. kikuchii* as follow: almost straight mandibles having dentate blade, long simple setae on the frontal border, concave frontal border, U-shaped dorsal sulcus, and triangular pleotelson having convex lateral margins. Among these characteristics, the long simple setae on the frontal border makes *E. kikuchii* to be easily distinguished from other *Elaphognathia* species (Ota, 2013).

Within the genus *Elaphognathia*, two species, *E. rimifrons* (Holdich and Harrison, 1980) and *E. kikuchii* (Nunomura, 1992), commonly have a long setae on the frontal border (Holdich and Harrison, 1980; Nunomura, 1992; Ota, 2013). However, *E. kikuchii* can be readily distinguished from *E. rimifrons* by the area of frontal border on which long setae distributed (present between mandibles in the former vs. present at the central area in the latter) (Holdich and Harrison, 1980; Ota, 2013).

In Korea, only one *Elaphognathia* species, *E. sugashimaensis*, has been reported from the subtidal zone by Song and Min (2016). However, the present species differs from *E. sugashimaensis* in terms of the narrower cephalon (0.9 times as long as wide in the former vs. 1.5 times as long as wide in the latter), the presence of the frontal processes (absent in the former vs. present in the latter), and the presence of the setae on the frontal border (present in the former vs. absent in the latter) (Song and Min, 2016).

The Korean materials of *E. kikuchii* are well accorded with the previous descriptions including original description of the species (Nunomura, 1992; Ota, 2013) in terms of the concave frontal border, the presence of long setae on the frontal border, the features of the mandibles, the shape of the pleotelson and dorsal sulcus, and the absence of the appendix masculine on pleopod 2. The Korean materials have a minor difference from the previous descriptions of the species (Nunomura, 1992; Ota, 2013) in terms of a small mediofrontal process on the frontal border (present in the former vs. absent in the latter). However, this difference is considered to be a variation appeared according to individuals, because we could observe both of the specimens with and whithout this small process within the materials collected from the same locality.

ACKNOWLEDGMENTS

This study was supported by the research funds from Chosun University (2018) and the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR 201801202).

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Received June 16, 2019
Revised July 9, 2019
Accepted July 10, 2019